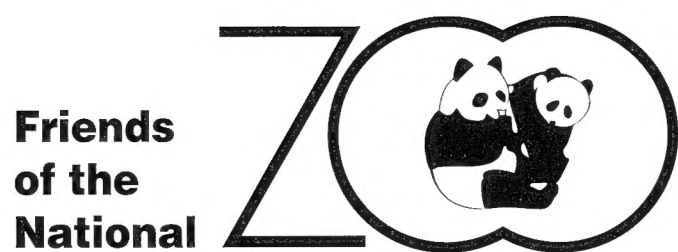


ZOOGOER

MAY & JUNE 1990





is a nonprofit organization of individuals, families, and organizations who are interested in helping to maintain the status of the National Zoological Park as one of the world's great zoos, to foster its use for education, research, and recreation, to increase and improve its facilities and collections, and to advance the welfare of its animals.

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Cover: *Born March 16, the three serval cubs (Felis serval) are the first serval births at NZP since 1970.*
(Photo by Milton H. Tierney, Jr.)

Call for Nominations

In accordance with Article II, Section 7 of our By-laws, the FONZ Board of Directors is hereby soliciting nominations from the membership.

Board Responsibilities

As members of a "working" Board, FONZ Directors "administer and manage" the affairs of the Friends of the National Zoo. The Board of Directors establishes the policies of the corporation, approves budgets and expenditures, and otherwise directs the activities of FONZ officers and employees. Members of the Board of Directors serve without pay.

Much of the Board's work is accomplished through committees.

- The **Education Committee** participates in development and oversight of FONZ-supported education and volunteer programs.
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The criteria by which potential candidates are judged for nomination to the Board of Directors are: The candidate's strong interest in supporting zoological education, research, and conservation in accordance with the purposes of our corporation; leadership; experience or skills that are needed and that would directly benefit the management and operations of FONZ; and the willingness and time to participate fully in FONZ work and activities. Candidates must be dues-paying members of FONZ.

Nomination Procedures

Nominations may be made only by dues-paying family, couple, or individual members in good standing. (Senior citizen, contributing and patron members of FONZ, and members who previously joined the corporation as life members are entitled to all rights and privileges of dues-paying family, couple, or individual members.) Employees of FONZ or the National Zoo are not eligible for membership on the FONZ Board of Directors.

Nominations must be submitted on an official FONZ Nomination Form with a biographical sketch of the nominee attached. Nomination forms can be obtained at the FONZ office or will be mailed upon request. For information or forms, call 673-4950. The deadline for submitting nomination forms and accompanying biographical sketches is July 5, 1990. Address submissions to: Robert A. Peck, Chair, Nominating Committee, FONZ, National Zoological Park, Washington, D.C. 20008.

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The quetzal, Guatemala's national bird. Painting by Elizabeth Gould for her husband John Gould's A Monograph of the Trogonidae, or Family of Trogons, 1835-38. (Photo by Mark Gulezian/Quicksilver Photographers for Lords of the Air: The Smithsonian Book of Birds, courtesy of Smithsonian Books.)

Guatemala Guards

*The sounds of
shaking trees,
falling branches,
and hooting animals
overhead shattered the calm
of a summer afternoon in a
section of unrestored Maya
ruins in Guatemala's Tikal
National Park...*

We looked up from our leisurely lunch just in time to see an adult male and female and two young spider monkeys traversing the forest canopy.

Suddenly, the monkeys leaped across a small clearing and vanished into the thick foliage of Tikal's luxuriant rainforest, only to reappear a few seconds later. For what was probably no more than half a minute, we stared in awe at the monkeys and they stared back at us. Then, as quickly as they had come, the monkeys turned, leaped into another tree, and disappeared into the forest.

In those few brief moments, the spider monkeys seemed to symbolize Guatemala's biological diversity, the extent of the remaining rainforest, and the country's determination to preserve both. Despite considerable habitat loss already, Guatemala still possesses enough undisturbed lands to serve as reservoirs for animals and plants now threatened throughout most of Central America.

To save its rainforests and other natural habitats, Guatemala created 44 new national parks and protected areas in 1989. While specific borders have not been set yet for most, their addition to a small, largely private system of nature preserves established earlier has vaulted Guatemala into first place (for now) among Latin American countries in percentage of land devoted to conservation.

Guatemala's action came none too soon. The same factors—overpopulation, economic development, deforestation, civil war, and political instability—wrecking natural ecosystems elsewhere in the tropics have struck Guatemala too. For example, Guatemala's population has grown from 2.8 million in 1950 to nearly nine million today, an increase of more than three percent a year.

Moreover, since the end of an internal insurgency in the mid-1980s, people have been streaming into Guatemala's undeveloped areas at a rate of 50 individuals a day. Particularly hard hit has been the Peten, the largely pristine northern third of Guatemala bordered by Mexico in the west and north and by Belize in the east. Slash-and-burn agriculture, cattle ranching, and increased logging cost Guatemala about 225,000 acres of rainforest each year, three-fourths of that in the Peten.

As a result, more than half of Guatemala's pre-Columbian rainforest has disappeared. "We face a very grave danger to our rainforest," says Andreas Lehnhoff, executive secretary of Guatemala's National Council for Protected Areas, a government agency set up in 1988 to coordinate policies for the country's new national parks.

"It was terrible, the amount of destruction—all in the Peten," Lehnhoff adds. "But now we have shown that Guatemala has the political will to protect its natural resources."

That will has been recognized outside of the country as well. "Guatemala is a significant biogeographic area in need of conservation," says Curtis Freese, World Wildlife Fund vice president for regional programs. "The international conservation community stands ready to help Guatemala take the additional steps necessary to protect its wild resources and make it a showcase for the rest of Central America."

JEFFREY P. COHN

*Though extinct in the U.S. and rare in Mexico, the jaguar (Panthera onca) is still common in Guatemala.
(Photo by Fiona Sunquist.)*

Tropical Treasures



What makes Guatemala important biologically is its geographic position and physical diversity. Located in the Central American isthmus, Guatemala serves as part of the land bridge between North and South America. Dozens of species have traversed this bridge over the past five million years, extending their range from one continent to the other.

Thus, the same Guatemalan forests that provide habitats for such common North American species as white-tailed deer, raccoons, coyotes, and gray foxes also harbor such typically Latin American species as brocket deer, tapirs, anteaters, and spider and howler monkeys.

Furthermore, Guatemala's tall mountains, steep valleys, highland plateaus, and humid coastal plains give it a range of wild lands found in few other places of comparable size (at about 42,000 square miles, Guatemala is slightly smaller than the state of Ohio). Wild lands range from the volcano-dotted Sierra Madre in the west, with peaks rising as high as 13,000 feet, to the Rio Dulce's lakes and mangrove swamps in the east, and from the jungles of the Peten in the north to the relatively dry, cactus-studded Motagua River Valley in the south.

These varied habitats have created within Guatemala a diversity of plant life unequaled in Central America outside of Costa Rica. Guatemala has more than 8,000 vascular plants (ones with sap-carrying channels) alone. Almost three-fourths of the country's mountainside flora are found nowhere else. And its 20 species of conifers, two of

which are thought to be endangered, make Guatemala second only to Mexico in diversity of these biologically and commercially important trees.

Despite habitat destruction, Guatemala has more rainforest than most other Central American countries. Panama, for example, has lost 40 percent of its tree cover in the last 40 years. The Mexican state of Chiapas, once the most heavily forested in the country, has lost a considerable amount of its forest, although much still remains.

Indeed, the almost unbroken stretch of tropical rainforest covering northern Guatemala and western Belize provides habitats for many species that are rapidly disappearing in other regions. Some species are found only in Central America; for others, Guatemala is at or near the northern limit of their range.

One such animal is the jaguar, the New World's largest cat. Once ranging into the southwestern United States from Arizona to Louisiana, the jaguar is now extinct in the U.S. and rare in Mexico. But turn a corner among Tikal's Maya ruins and you might run into one.

Guatemala's rainforests are also home to black howler and black-handed spider monkeys, both endangered in the wild. These monkeys are found only in Guatemala and its neighboring countries, and their prospects for survival depend on preserving their rainforest habitat.

Guatemala's wildlife also includes two of South America's most unusual animals—the giant and lesser anteaters. The diet of the



lesser anteater or tamandua includes ants that build nests called *tachinoles* in trees. If disturbed, tamanduas release a strong, unpleasant odor that has earned them the nickname “stinkers of the forest.” Like the monkeys, both giant and lesser anteaters are endangered in Guatemala.

The quetzal, Guatemala’s national bird, is also endangered. The quetzal lives in mountain rainforests from southern Mexico to western Panama. It has a beautiful crimson breast, blue and green throat, and long metallic green streamers that cover the tail and reach two feet in length.

According to Maya legend, the quetzal got its color from the 16th-century Battle of Quetzaltenango, where 30,000 Maya Indians were killed by Spanish soldiers. After the battle, huge flocks of quetzals are said to have descended on the field and covered the slain Maya warriors with their bodies. The quetzals’ feathers soaked up the blood, staining them red.

Sadly, one species of bird unique to Guatemala seems to have become extinct altogether. The pok or giant grebe was a flightless water bird found only at Lake Atitlan, 50 miles west of Guatemala City, the capital of Guatemala. As recently as the early 1970s, a few hundred poks dotted the lake. But homes built along Atitlan’s shores and a 1976 earthquake, which opened underground cracks below the lake that drained its waters, greatly reduced the birds’ favored reed and cattail habitat. A 1987 survey by the U.S. Fish and Wildlife Service and

the International Council for Bird Preservation found no poks remaining in the lake area.

The disappearance of the pok illustrates the importance of protecting the habitats of wildlife, but until the 1970s Guatemala did little in this regard. According to James Nations, vice president for Latin American programs at Conservation International and parks advisor to the Guatemalan government, the country had several so-called national parks, but most were little more than urban statues, swimming pools, and jogging trails.

Then in 1977 a group of scientists and wildlife conservationists associated with San Carlos University in Guatemala City began creating a new type of nature preserve—a biotope. Centered around a single flagship species, each biotope was designed to protect that species and its habitat, along with that of other animals. While small, they would remind Guatemalans of how the country’s natural resources could be protected and provide a place to train wildlife researchers, managers, and guards.

Perhaps the most spectacular of the biotopes, which are run by San Carlos University’s Center for Conservation Studies (CECON), is the Mario Dary Rivera Preserve. Named after a former university president, father of Guatemala’s conservation movement, and founder of CECON, the reserve protects 2,800 acres of mountain cloud forest—prime habitat for the symbolically important quetzal.

The reserve features lush green mountainsides, fast-flowing rivers,



The giant anteater (Myrmecophaga tridactyla) can extend its tongue as much as 24 inches when feeding. Opposite page: The Guatemalan howler monkey (Alouatta pigra). The largest New World monkeys, howlers get their name from their resounding calls. (Photos by K.H. Redford.)

and cascading waterfalls. Orchids, some with flowers no bigger than a person's thumb, surround a visitors' path that winds through the reserve. White, purple, and bluish mushrooms spring up through the moist leaf litter that covers the ground. Near the top of the trail, a forest clearing opens like parting curtains to reveal a magnificent view of neighboring mountain ridges.

To the east, just before the winding Rio Dulce empties into the Bay of Honduras near Livingston, the Chocon-Machacas Reserve protects nearly 18,000 acres of mangrove-lined waterways at the edge of a deep-blue lake known as El Golfete. The mangrove waterways are home to West Indian manatees, the same species that lives in the southeastern U.S. Ranging from Florida to Brazil, the manatees or sea cows are herbivorous mammals found in shallow coastal waters, estuaries, and rivers. They, too, are considered endangered in Guatemala and threatened elsewhere in their range.

CECON's third biotope lies on the northeast shores of Lake Peten-Itza in northern Guatemala. The Cerro Cahui Reserve's 1,600 acres of tropical forest help preserve habitat for the endangered Peten or ocellated turkey, a slightly smaller bird than the common turkey. Male ocellated turkeys have blue wattles dangling from their necks and striking eyespots on their rounded tails. The species is found only in Guatemala, Belize, and Mexico's Yucatan Peninsula.

A fourth biotope protects three species of marine turtles and their egg-laying sites on Guatemala's Pacific coast. The Monterrico Re-

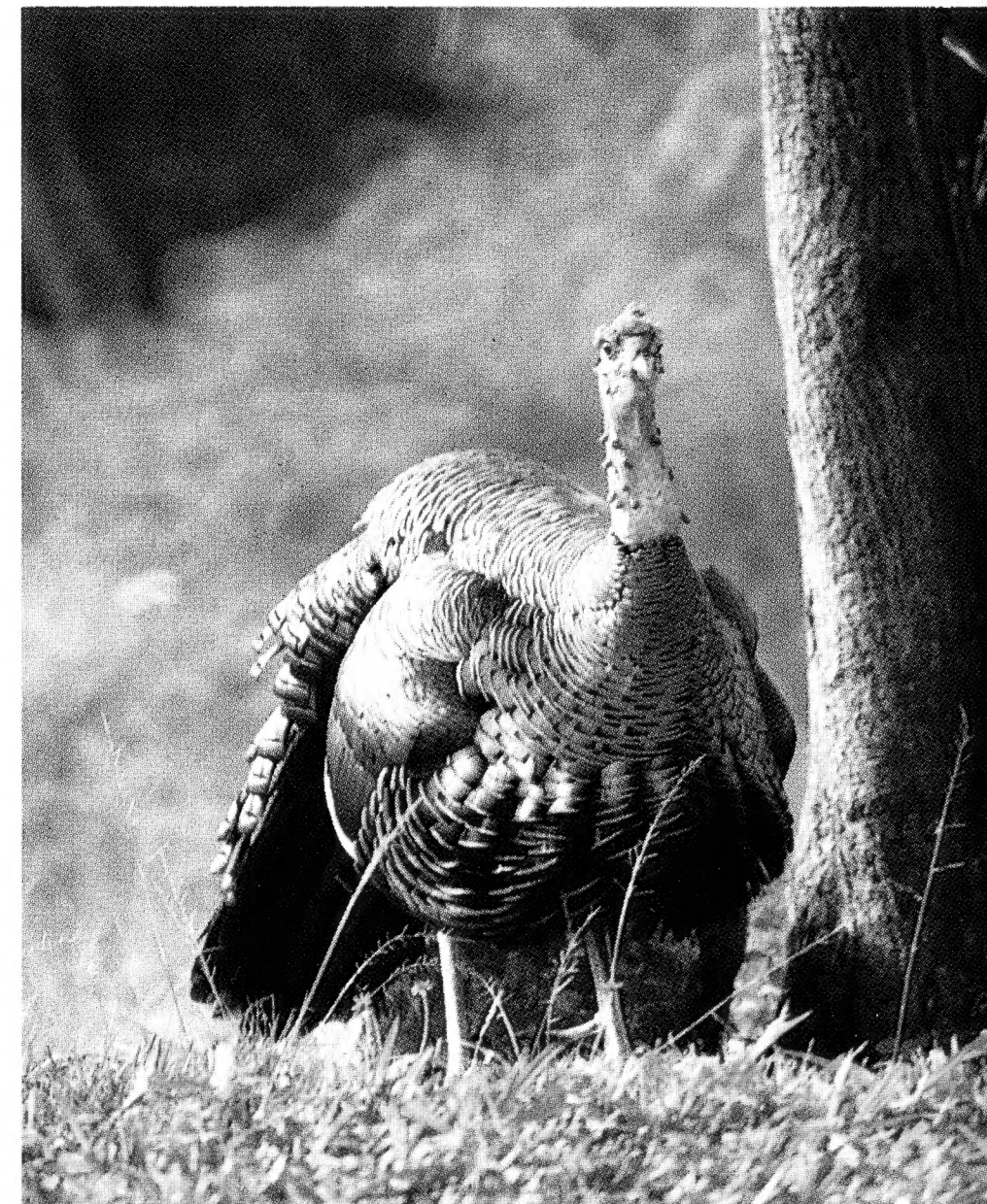
serve boasts billowing rushes and red, white, and black mangrove trees that line crisscrossing waterways where three rivers flow into a man-made inland channel paralleling the ocean. Monterrico's beaches of black sand, colored by lava from nearby volcanoes, also draw thousands of tourists annually.

"We wanted to protect Guatemala's natural heritage," says Juan Carlos Godoy, former director of CECON and a prime mover behind creation of the biotopes. "But we recognized that they were only a first step toward conserving our natural resources."

Not until 1987, however, was the second step possible, when the Guatemalan army ended its separate administration of the Peten and returned it to the government. That opened the Peten for development, but also created the potential for significant conservation.

Acting quickly, in 1987 CECON added three new biotopes: Rio Escondido, Naachtun/Dos Lagunas, and San Miguel/La Palotada. All three are in the Peten and each is seven times larger than CECON's four previously established biotopes combined. The new biotopes protect relatively pristine habitats where so far there has been only minimal economic development.

More important, after more than a year of debate, the Guatemalan Congress passed a new law in January 1989 creating 44 new national parks and protected areas. The new parks, several encompassing some of CECON's biotopes and previously established parks at Tikal and Lake Atitlan, total 2.5 million acres. In all, Guatemala's national



The Cerro Cahui Reserve helps to protect the habitat of the endangered Peten or ocellated turkey (Agriocharis ocellata), found only in Guatemala, Belize, and Mexico's Yucatan Peninsula. (Photo by Fran Woods.)

Left: Northern tamandua (Tamandua mexicana). Tamanduas are nicknamed "the stinkers of the forest" because they release a pungent, unpleasant odor when disturbed. (Photo by Kent Redford.)

parks, biotopes, and other protected areas now encompass nearly four million acres or 14.5 percent of the country's land.

Despite the potential for conservation the new parks represent, problems remain, Nations says. For one, divided political control among three different government agencies and a university group makes coordinating policies for the parks difficult. For its part, though, CECON wants eventually to transfer the biotopes to the government. "We are a university group," Godoy says. "We conduct research and educate students. We do not best manage public lands."

Additionally, the Guatemalan law did not set precise boundaries for the new national parks. Rather, it authorized technical surveys of each park to determine what its borders, management designation, and permissible levels of human activity should be. Teams of experts led by Nations began surveying the parks in 1989 and should finish this year, at least in the Peten, he says.

Furthermore, Guatemala, like most developing nations, lacks enough trained wildlife researchers, managers, and guards to protect and maintain the parks properly. "We do not have enough trained people," Godoy says. "We will need help getting them."

That help is on the way. The World Wildlife Fund, the Nature Conservancy, Conservation International, and other U.S. and international environmental groups have already committed funds to help train Guatemalan park managers, buy needed equipment, and con-

duct scientific research to obtain information necessary to manage the parks. Also contributing is the National Geographic Society, which hopes to establish a "Ruta Maya" to protect cultural and natural sites as well as to promote tourism in Guatemala, Belize, and southern Mexico.

Meanwhile, Guatemala's new national parks and protected areas will not conserve wildlife and lands at the expense of all human activity, their supporters note. "We could not justify protecting such large areas of land if conserving them did not benefit people, too," Lehnhoff says. "We want to help people live in harmony with nature and not destroy it."

Lehnhoff says the national parks will range from closed wildlife refuges with little or no economic development to multiple-use areas. The latter could include some logging, harvesting such forest plants as jade palm, allspice, and chicle (used in chewing gum), and tourism, especially at Tikal and other historical sites.

The emphasis of the new national parks, however, will remain on the development of renewable use of sustainable natural resources. "Events are moving very fast in my country," Lehnhoff says. "We are in a race against time to protect our natural resources and wildlife. For the sake of Guatemala's future, we have to win that race." ♣

Jeffrey P. Cohn is a Washington freelance writer who writes often about zoos and research on wildlife and conservation.

The Zoo Biology Training Course in Guatemala City

The National Zoo's Zoo Biology and Animal Management Training Program (ZOOBAM) was initiated in 1987 to assist zoos in developing countries improve the husbandry of wild animals in their facilities. The program's secondary goals are to guide the development of public education programs and to establish scientific management of zoo animals. Five courses have been given in locations in Thailand, Malaysia, Brazil, China, and Guatemala.

La Aurora Zoo in Guatemala City hosted the fourth Zoo Biology Training Course for two weeks in May 1989. The course differed from previous offerings in being a regional program in which the 24 participants came from six countries: Mexico, Guatemala, Belize, Costa Rica, Nicaragua, and El Salvador. Instructors included Sandra Skrei (Education Curator from the Fossil Rim Wildlife Foundation in Glen Rose, Texas), James Murphy (Herpetology Curator of the Dallas Zoo), Bruce Beehler (Assistant Director of the Milwaukee County Zoo), Jacques Prescott (Acting Director of the Jardin Zoologique de Granby, Quebec), Charles Pickett (Assistant Curator of Birds at the NZP), and me.

One of the program's fringe benefits is the opportunity for instructors to gain insights into the challenges confronting zoos in the developing world. The regional solutions to these challenges are often ingenious, effective, and inexpensive. Guatemala offered us an interesting example.

During every course we conduct exercises on animal restraint and handling. This is a topic of vital concern to zoo biologists because improper restraint can have dire consequences for the animal, as well as for the keepers. Our restraint exercise in Guatemala was to capture and ear-tag a group of North African maned sheep,

or aoudad (*Ammotragus lervia*). The rope work of the Spanish caballeros is alive and well in La Aurora Zoo! The three keepers demonstrated admirable teamwork and roped the sheep one by one with minimal stress to the animals. In most developing-country zoos, keepers have limited education, but in all zoos they are the backbone of the organization.

Each training course has its aftereffects. As a result of many hours of discussion with the course instructors, La Aurora's General Curator, Lorena Calvo, prepared a comprehensive multi-year proposal for training Mesoamerican zoo personnel. She continued to work on this during June and July, when she participated in the Wildlife Conservation and Management Training Course at the NZP's Conservation and Research Center in Front Royal, Virginia. Recently, two conservation organizations that have dedicated considerable effort to Central America decided to fund the program: the Wildlife Preservation Trust International of Philadelphia, and the Fossil Rim Wildlife Foundation. Finally, one course participant, Ines Vielman, decided to pursue her career goals with even more training: She recently spent three months as a volunteer field assistant with the Conservation and Research Center's Earth-watch program.

The 1990 Zoo Biology Training Courses will be held in Indonesia, Mexico, and Morocco. As the program celebrates its third anniversary, it is heartening to see such enthusiastic cooperation among zoos of different nations to improve animal management and species conservation. ♣

—Christen Wemmer
Assistant Director
Conservation and Research Center

Who's the Mother?

Fostering Behavior in Endangered Hawaiian Monk Seals

DARYL BONESS

The Hawaiian Islands. The name evokes images of the colorful birds, lush vegetation, and fragrant flowers of Hawaii, Kauai, Maui, and Oahu. Paradise, in a word. But there is another whole chain of Hawaiian Islands—barren, arid dots in the South Pacific only a biologist with a mission would care to visit.

Located several hundred kilometers away from the main islands, the Northwestern or Leeward Hawaiian Islands were created by the breakdown of coral reefs. These uninhabited islands are extremely small—often no more than a few square kilometers in area—sparsely vegetated, and, unlike the towering volcanic main islands, rise only a few meters above sea level. But so important are they for wildlife that the entire chain is protected as the Hawaiian Islands National Wildlife Refuge.

Endangered green sea turtles and many sea birds, including the endangered Laysan albatross, Laysan duck, and Manx shearwater, breed on these islands. But most important, the world's last 1,700 Hawaiian monk seals (*Monachus schauinslandi*) breed on these islands, and only on these islands. My mission was to study these endangered seals in their natural habitat.

We do not know much about the historical size of this population but we do know that in 1859 the ship *Gambia* brought some 1,500 monk seal pelts from these islands to Honolulu. The first good surveys of the population weren't made until the late 1970s, when a count in 1977 estimated a total population of only 700 animals. In the past decade the population appears to have increased by about 1,000 animals, but the Hawaiian monk seal's existence remains imperiled. Seal populations, especially small populations, can disappear rapidly. Recently, for example, an epidemic of a canine distemper-like virus in Europe killed nearly 18,000 harbor seals—about 70 percent of the entire European population—in less than two years.

In fact, the only other seal with a higher probability of extinction is the Hawaiian monk seal's cousin, the Mediterranean monk seal. With fewer than 500 animals, dispersed across the

Right: Monk seals stretched out on the sand. When nursing females move too close to each other, they may fight, causing their pups to scatter. Sometimes the pups return to the wrong females, thus giving rise to foster relationships. (Photo by Daryl Boness.)



borders of several Mediterranean countries, this monk seal population is much more difficult to protect and manage than the Hawaiian one.

The Hawaiian monk seal has been protected since 1972, but management of the population was stymied by our lack of information about the species. So in 1983 the National Marine Fisheries Service prepared a Species Recovery Plan under the Endangered Species Act that established a set of priority research questions. And I set out to study the behavior of Hawaiian monk seal mothers and pups.

Why was a study of mothers and pups priority research? An anecdotal report suggested that fostering—mother seals caring for pups not their own—was fairly common in a colony of monk seals in which pups were smaller at weaning on average than pups in several other colonies. The goal of my study was to determine the normal pattern of maternal care in monk seals, the frequency of fostering behavior, and, most important for management efforts, whether fostering has a

negative effect on the development and survival of monk seal pups.

Monk seals, like many other seals, gather at traditional locations, called rookeries, once a year to give birth and to care for their young. But not just any island or area on an island is suitable for a rookery in this species. High midday temperatures force mothers and pups to seek refuge in the water off the beach. As this part of the South Pacific Ocean abounds in both reef sharks and tiger sharks, the water adjacent to the beach must be shallow to prevent these sharks from swimming in to snatch the vulnerable, inexperienced pups.

With several student assistants, I studied colonies on two islands that met this condition but offered quite different breeding conditions. On East Island in the French Frigate Shoals about 50 pups are born each year in a relatively small space along a 1,000-yard stretch of beach. On Laysan Island only about 30 pups are born each year although the breeding area is more than three times larger.

Hawaiian monk seal pups are born over a period of about five months. Each female gives birth to a single pup and remains at the rookery, without feeding, for about 41 days to care for it. Then pups are abruptly weaned and abandoned. Females depart for sea and the pups remain on the beach, where they will fast for two weeks or more, before they are ready to venture off to feed for themselves. (The reason for this fast after weaning, which also occurs in other species of seals, is a mystery.) Departing females are often accompanied by males who have been patrolling the waters off the beach, waiting for a potentially receptive female. We don't know exactly how long after weaning females mate, but they are thought to do so within a few weeks.

Getting to East Island was our first task—and no simple feat. In Honolulu we had to charter a twin-engine Beechcraft plane to fly us to Tern Island, a 3,000-foot man-made island about five miles from East Island. Landing on Tern Island made me feel like a World War II fighter pilot trying to dodge enemy flak—but in this case the flak was sea birds, huge albatrosses and frigate birds with wing spans up to 11 feet! As we approached the island, the pilot and co-pilot donned crash helmets—just a precaution, they assured us, in case one of the hundreds of birds stirred up by the sound of the incoming plane should hit and shatter the windshield.

From Tern Island—a civilized place boasting a building that serves as local headquarters for the Hawaiian Islands National Wildlife Refuge and houses the refuge manager and his assistants—we took a 17-foot Boston Whaler to East Island, which is accessible only by small boats.

As soon as we arrived on East Island, we established a tent camp, home for two to three months while we collected data. This

barren Hawaiian island was hardly paradise. There was no respite from the blazing, near-tropical sun. Sitting on the coral sand while making observations made us easy prey for the avian ticks that thrived on the hordes of breeding sea birds. And we ate no gourmet meals, our only provisions being the canned and dried foods we brought with us. But the excitement of our discoveries made it all worthwhile.

To conduct the study, we had to be able to identify individual seals. Sometimes we could use distinctive shark-wound scars on animals but more often we marked mothers with black dye and newborn pups with Lady Clairol bleach. The island's topography didn't offer us enough cover to do this in daylight without disturbing the seals, so we marked at night when the animals were less likely to see us sneaking up on them. This clandestine operation involved slithering on our stomachs to within about 30 feet of the seal and squirting the marking solution with a large syringe.

We watched the marked seals from sunrise to sunset, observing as many hours as possible so we would see the beginning of fostering relationships as often as possible. For the same reason we worked seven days a week. With this regime, we found that Hawaiian monk seal females fostered pups far more frequently than we expected. On East Island, 26 out of 30, or 87 percent, of the females we observed throughout lactation fostered pups, and on Laysan Island, 7 out of 16, or 44 percent, fostered.

Fostering is rare in most seal species. In elephant and gray seals, where fostering is prevalent, frequent separations between mothers and pups occur. Hawaiian monk seal mothers, on the other hand, normally stayed within a few feet of their pups, and female-pup pairs were widely spaced. On East Island, the average density of females was about one every 1,500 square meters, or about half a football field per female; on Laysan Island the density of females was nearly one every 3,000 square meters. In fact, their spacing indicated that females tended to avoid each other.

We don't know why monk seal females don't form clusters as females in other seal species that breed on land rookeries do. One possible explanation is that in these other species the males are hauled out among the females and compete aggressively with one another for access to the females. Clustering might protect the females from harassment and reduce the risk of pups being trampled by males. In contrast, male monk seals are usually patrolling adjacent waters, not fighting on the beaches. Thus in monk seals there may be no advantage to female clustering.

In other mammals, fostering most commonly occurs in small social groups of closely related individuals, where females appear to care cooperatively for each other's young. Alternatively, fostering may occur in large aggregations of animals where offspring



The Northwestern or Leeward Hawaiian Islands are home to many endangered species, such as green sea turtles.

Top: Many birds, such as the frigate bird, nest in the Hawaiian Islands National Wildlife Refuge. (Photos by Daryl Boness.)

become separated from their mothers and are taken on by a female who has lost her own young. Neither is true of monk seals. Most monk seal foster relationships begin when two females fight. (Such fights usually arise when two females with pups move within a few feet of each other.) The pups often scatter, returning after a minute or two when the fighting abates. The pups sometimes return to the wrong females, however, and each female accepts the other's pup.

A single female might be involved in several of these switches during the 41-day lactation period. In our study, the average female fostered 2.5 different pups and some females fostered up to five different pups. Interestingly, females did not lactate any longer no matter how many pups they cared for. Females left the rookery at the end of about 41 days regardless of the size of the pup they were suckling.

Next we wanted to determine whether fostering had any adverse effects on pups. Fostering is generally believed to be reproductively costly. An individual animal normally optimizes the survival of its own offspring and genetic material; by investing milk and care on foster young it may be reducing the survival of its own young. But this was not the case for Hawaiian monk seals. Despite some pups being cared for by as many as six different females, on average, there were no adverse effects on either pup development or survival when their mothers fostered others. Yet, among pups whose mothers fostered, some pups did much worse than average and others did much better.

Some fostered pups were smaller than average at weaning because they suckled for less time than they would have if they had been with their own mother throughout the nursing period. Other pups suckled longer and were larger at weaning. One pup nursed for more than 60 days from other females while its mother fostered others; it would normally have spent just 41 days with its own mother. But despite these deviations from the norm, there was no difference in the survival of the pups whether their mothers had fostered or not.

To examine pup survival after the lactation period, we returned to our study sites a year after our initial work and searched for our marked animals. Provided that searching is thorough enough, failure to re-sight a marked individual is a good indication that the animal is dead because we know that yearlings do not move away from the region where they were born. We re-sighted 40 of the 47 marked pups on East Island and Laysan Island a year after they were born. The seven offspring that were not re-sighted were nearly equally divided between having mothers who fostered and mothers who did not.

The results of our study suggest that while fostering behavior occurs more often among Hawaiian monk seals than any other colony-



A pup paddles just off the beach. For rookeries, monk seals have to select beaches with shallow water so that sharks will not swim in to prey on the pups. (Photo by Daryl Boness.)

breeding mammal, it is not a major factor contributing to mortality in this highly endangered species. That relatively fewer females fostered on Laysan Island than on East Island also suggests that density of seals contributes to the occurrence of fostering. But density is probably not the "cause" of fostering behavior because even on East Island, where the density of females is the highest for this species, density is much lower than in seal species that do not foster.

Because pups of mothers who foster are just as likely to survive as those of mothers who do not, fostering will not be selected against; and so long as large numbers of females are willing to serve as foster mothers, this behavior will be maintained in the population. The still-unanswered question is how such a high frequency of fostering evolved in the first place. Possibly kin selection was important: That is, females may have been will-

ing to foster pups because these pups very likely were genetic relatives. Resolution of this puzzle awaits further research on the genetic similarity of individual Hawaiian monk seals.

Once a species is identified as threatened or endangered, it can be successfully managed to prevent extinction only with a thorough understanding of its biology (if it is not already known) and the factors that are contributing to its depletion. Understanding the behavior of animals is often an important link in this process—even if only to eliminate, as we did, a suspected factor in a species' decline. Clearly, other reasons must be sought for the decline of the Hawaiian monk seal. ♣

A scientist in the Zoo's Department of Zoological Research, Daryl Boness has studied seals in inhospitable habitats around the world.

PINNIPEDS AND PLASTICS

Visitors to the Zoo cannot buy balloons. Nor do they get lids and straws with their sodas. Ingested, a plastic straw or lid that has blown into an enclosure can kill an animal. Lost, a helium-filled balloon can blow out to sea, deflate, and be mistaken for food by sea turtles or whales. Limits on plastic containers, vigilance by groundskeepers, and signs help protect the Zoo's animals in their open enclosures but, in the wild, animals suffer daily the consequences of careless garbage disposal. Plastics, the most common type of litter found at sea, have had a profound impact on pinnipeds. As reported by the Center for Marine Conservation and the National Marine Fisheries Service (NMFS), each year plastic netting and debris kill as many as 50,000 northern fur seals in the North Pacific alone through entanglement and ingestion.

Seals, sea lions, and walruses belong to the order Pinnipedia ("wing-footed" in Latin). Although pinnipeds feed at sea, they bear their young on land, unlike other sea mammals such as whales. Consequently, pinnipeds encounter both plastics dumped at sea and debris such as fishing line that washes up on shore. Some pinnipeds are opportunistic feeders and swallow their prey whole; they can mistake clear floating plastic products for squid and other prey. These plastics cannot be expelled once they are ingested. In addition, pinnipeds, especially playful pups, may become entangled in discarded fishing line, nets, six-pack beverage rings, and plastic strapping bands—these products may not degrade for



Gray seal (Halichoerus grypus). Plastic or nylon fishing nets entangle many seals, which later suffocate as they grow older and their necks expand. (Photo by Daryl Boness.)

centuries. Yoked by plastic, the pinnipeds can suffocate as they grow older and their necks enlarge.

In the last 40 years, plastic production has increased to over 50 billion pounds a year. Because of its light weight, strength, and durability, plastic has become ubiquitous in nearly every industrial and commercial arena. However, the very qualities that make plastic desirable, especially durability, make it a particular threat to marine animals.

Ships in the open sea dump plastic and other garbage directly into the water for the sake of convenience and economy. Merchant and military ships, recreational and passenger ships, commercial fishing boats, and oil-drilling platforms combined leave an estimated 14 billion pounds of plastic in the oceans each year. Currents may carry this litter thousands of miles. During a study of Steller's sea lions on the Aleutian Islands in Alaska, researchers identified

litter from Japan, the Soviet Union, South Korea, mainland China, Taiwan, Norway, and the United States.

Plastic garbage ends up in the sea in less direct ways. Plastic sheeting from disposable diapers, plastic tampon applicators, and sandwich bags, when flushed down the toilet, can ultimately pollute the ocean. Furthermore, some plastic garbage, because it is lightweight, blows into streams and rivers that flow into oceans.

Fishing line, nets, and gear also pose a serious threat to marine wildlife. Japan, South Korea, and Taiwan are the three largest users of nylon monofilament gill nets, which form walls up to 50 miles long and 30 feet deep, called by some "Curtains of Death." The nets drift through 30,000 to 40,000 miles of ocean each day. When lost (up to 650 miles of net each year), the nets do not degrade but roll up on themselves or continue to "ghost fish" until they become so entangled with dead marine life that they sink to the bottom of the ocean. Entangled fish become bait for other animals such as diving birds and pinnipeds, which in turn become entangled or trapped. Similarly, lost fishing line continues to drift and entangle animals for decades.

The plastic menace to marine life first became evident in the 1960s, when researchers noticed an increase in the entanglement of northern fur seals on Alaska's Pribilof Islands. Plastic fishing gear was becoming more common, and by 1964 all netting materials made in Japan, the major supplier of nets to U.S. fisheries, were made of plastic. Studies conducted in 1969 showed that the rate of fur seal entanglement had not decreased. A 1982 study by the NMFS estimated a fur seal mortality of 50,000 a year, mostly pups and juveniles. At about the same time, researchers found that endangered Hawaiian monk seals were becoming entangled in fishing gear and other plastic debris, and were dying.

In 1984, a group of concerned scientists met in Honolulu, Hawaii, at the Workshop on the Fate and Impact of Marine Debris to share information on the effects of marine debris on wildlife. This meeting provided the impetus for more research and increased awareness.

In 1987, 10 years after its introduction, the U.S. Senate unanimously ratified Annex V of the International Convention for the Prevention of Pollution from Ships. The Annex is the first international convention specifically to address plastics pollution. The Annex makes it illegal for ships registered in the more than 29 signatory nations, and ships within the waters of these countries, to dump plastics overboard. However, military and other public vessels are exempt. Each signatory nation is to handle these vessels separately; Congress requires U.S. Navy vessels to comply by 1992. Unfortunately, while Annex V should be a strong weapon against marine pollution, the Coast Guard currently lacks the funds and personnel to enforce it effectively in U.S. waters.

Even properly disposed of on shore, garbage still poses a problem in that it is outgrowing the capacities of garbage disposal facilities. Currently, there are four strategies directed toward garbage: land filling, incineration, recycling, and source reduction. Each has benefits and drawbacks, but some environmentalists argue that only decreasing the use of disposable materials, the source of most garbage, will protect our land and sea effectively over the long run. As previously mentioned, the Zoo does this by limiting the use of plastic packaging in food items. If consumers help by avoiding individually wrapped foods and choosing and recycling glass and aluminum containers, perhaps they and the seals won't have to see plastic bags and empty soda bottles littering their favorite beaches. ♣

—Alexa Mergen
Former Assistant Editor of ZooGoer

CAPITAL CROAKERS

Joseph M. Lugo

Have you ever seen a frog too big
to hold in your hand?
How about one so small it could
sit on the end of your pencil?

West Africa's seven-pound Goliath frog (*Conraua goliath*) jumps 10 feet at a time and is a foot long between its snout and its vent. Brazil's *Psyllophryne didactyla* is quite different. This little frog is tiny enough to sit comfortably on the Goliath frog's nickel-sized eye!

Besides these two species, there are about 3,500 other kinds of frogs living in habitats that vary from deserts and bleak mountains to swamps and tropical rainforests. In fact, frogs are found on most islands and on all continents except Antarctica.

Frogs are amphibians. While some amphibians always live on land or in water, most live up to their name. *Amphibia* means "an animal living a double life," and most amphibians do just that by spending part of their lives on land and part in water.

Amphibians are "cold-blooded" animals, or ectotherms. Their bodies produce a little heat, but their body temperature depends on the temperature of their surroundings.

To keep their bodies from getting too cold, frogs on land bask in the sun to warm up. To keep from overheating, they hide from the sun by finding shade or by burrowing beneath the soil to cool off. Frogs in ponds and streams control their body temperature by swimming into cool or warm areas in the water.

Frogs that spend most of their time in water, such as Australia's banjo frog (*Limnodynastes dorsalis*), often have

long, slender, streamlined bodies that let them glide through the water. Their extra-long legs are perfect for swimming and jumping.

Frogs that live on land, like North America's Eastern spadefoot toad (*Scaphiopus holbrookii*), are quite different. They usually have short, squat bodies and very short legs. These frogs often dig into the ground to stay cool and moist.

North America's spring peeper (*Hyla crucifer*) and other frogs that live in trees tend to have flat bodies to help them keep their balance on flat leaves and tree trunks. Some species have special toes so they can hold on to thin twigs. These special toes have sticky ends that let them climb up smooth, vertical surfaces.

You can see exotic frogs like the yellow-banded poison dart frog (*Dendrobates leucomelas*) and the African clawed frog (*Xenopus laevis*) at the National Zoo, but there are plenty of interesting frogs you can see in local ponds and streams as well.

The Eastern spadefoot toad got its name because its feet are shaped like shovels. Like the leopard frog (*Rana pipiens*), it digs into the ground when the weather is dry and stays in the moist soil.

The leopard frog lives on land, but breeds in water. The green frog (*Rana clamitans*) and the bullfrog (*Rana catesbeiana*) both live near lakes and streams, which they dive into in

Continued on page 16

Continued from previous page

case of danger.

Green frogs gather around a body of water at breeding time. The males choose an area on the shore and then fight off other males who try to take it away. Male frogs often wrestle over territory by standing on their hind legs and trying to push each other over.

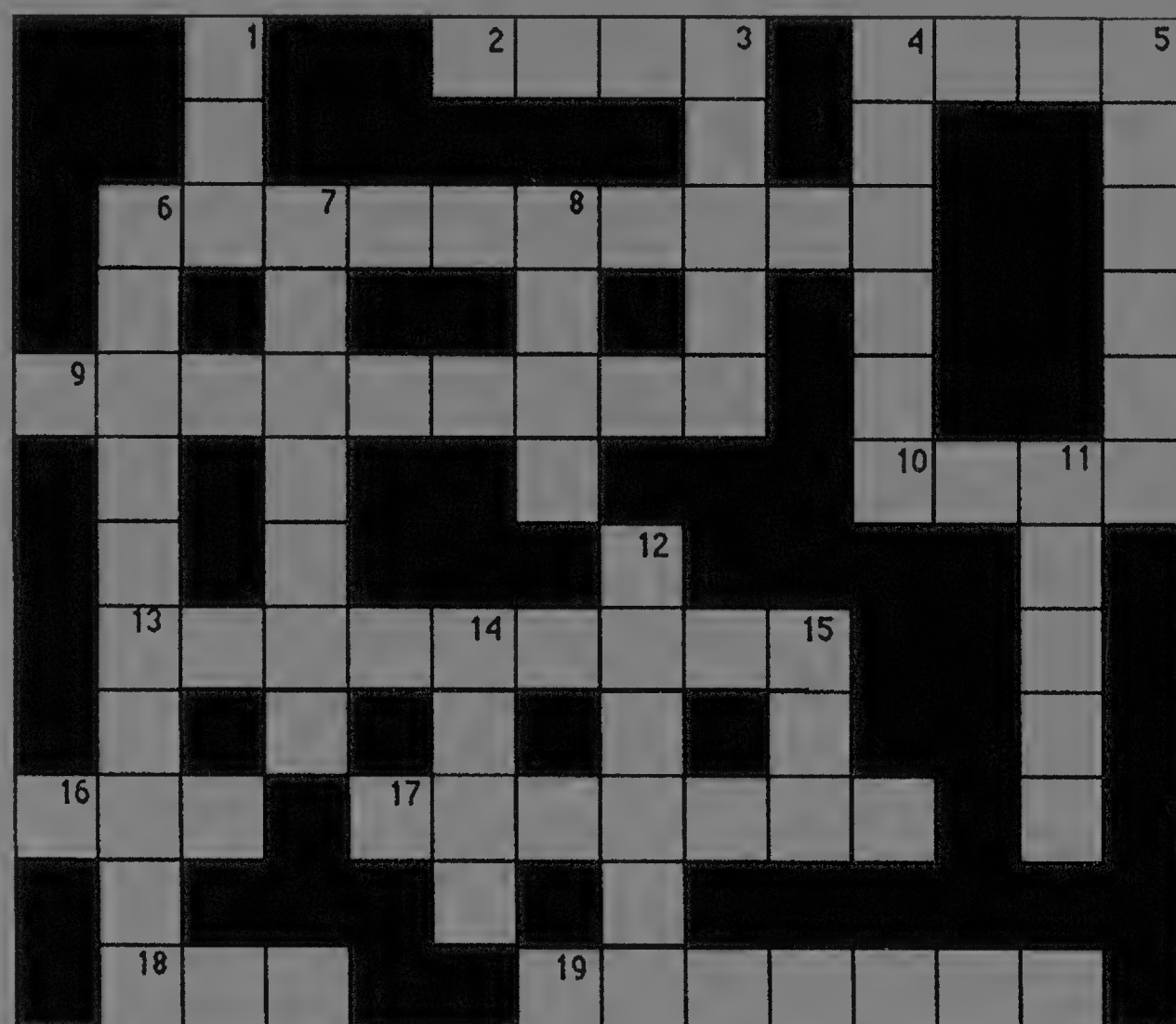
Male bullfrogs also pick out a special place in the pond during breeding time and keep other males out. If a male swims into another male's territory, it will be attacked.

Most local frogs eat insects, but the bullfrog also eats

mice, small snakes, and other frogs. There is at least one report of a bullfrog jumping and catching a sparrow in full flight, then swallowing it whole!

The rules of frog life are simple: If something smaller than you moves, eat it; if something larger than you moves, it may want to eat you, so get away fast.

Remember that frogs react quickly to motion. So, if you want to observe frogs in nature, you've got to sit still beside a pond for a long time. Frogs don't mind if you talk while you wait. The sound of your voice may even encourage them to croak. One false move, however, will send them splashing into the safety of the pond.



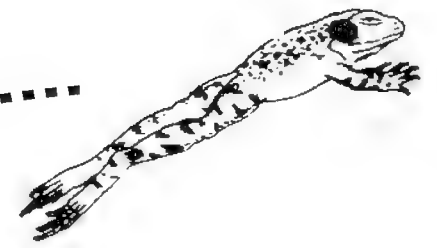
ACROSS:

2. Frogs in water _____ into cool or warm areas in the water to control their body temperature.
4. Certain species of these flying mammals eat frogs.
6. Frogs live on every continent but this one.
9. This frog gets its name from its shovel-like feet.
10. Frogs use these to dig, swim, and jump.
13. The largest frogs in North America.
16. A bullfrog will sometimes ____ a mouse or a snake.
17. The largest frog in the world.
18. Frogs bask in the ____ to warm up.
19. Most local frogs eat these.

DOWN:

1. West Africa's seven-pound frog jumps this many feet in one leap.
3. Some frogs dig into the ground to stay ____.
4. The smallest frog in the world comes from this country.
5. Some frogs live in these wet, muddy places.
6. These animals live part of their lives in water and the other part on land.
7. A young frog before it loses its tail.
8. Frogs might stay in the shade to stay ____.
11. These frogs wrestle by standing on their hind legs and trying to push each other over.
12. Frogs react quickly to this.
14. The amphibian this puzzle is about.
15. If you want to see frogs in a pond, you have to ____ still.

LOCOMOTION



Green frogs (*Rana clamitans melanota*) can be seen near lakes and streams in the Washington area.

Top: The bright colors of this green-and-black poison arrow frog (*Dendrobates auratus*) warn away predators. (Photos by Jessie Cohen, NZP Graphics.)

Frogs move from place to place by hopping. Scientists call this kind of locomotion, or movement, “saltation.” But frogs aren’t the only saltatory animals. Kangaroos, rabbits, and some rodents and insects also hop from place to place.

An adult frog’s skeleton is perfect for jumping. There are no ribs to crack, and the short, stiff backbone will not break when the frog lands. Although other amphibians have long tails, a frog’s tail is just a single bone inside the body. With a long tail, a frog would not be able to jump as well as it can without it.

A close look at a frog’s body shows that its hind legs are about twice as long as its front legs. On land, the frog uses its long hind legs to jump, and its short front legs to cushion its landing.

Although many people have seen frogs jumping on land, most do not know that a frog goes through the same four steps every time it jumps.

First, the frog’s short front legs raise the front part of its body off the ground. Its powerful hind legs are now in the air, ready to spring.

Then, the hind legs stretch out and down and fling the frog into the air. Frogs go farthest when they take off at a 45-degree angle.

After that, the frog sails through the air with its eyes shut tight.

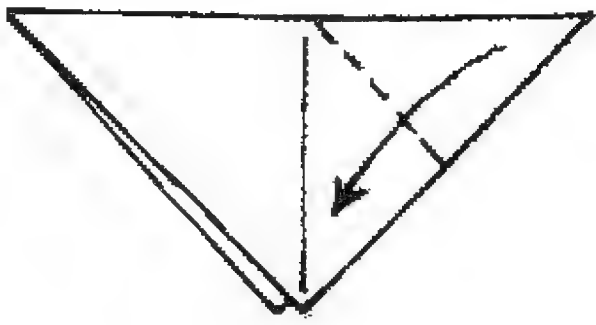
Finally, the frog lands. After its front legs break the fall, the frog’s chest hits the ground. Then its hind legs flex and press against the body, ready to leap forward again.

If you look in the shallows of permanent bodies of water in the Washington area you might be able to see the Northern cricket frog (*Acris crepitans crepitans*) actually jumping across the water. The cricket frog is one of about a dozen different frog species that travels on the surface of the water by landing flat and jumping quickly before it sinks. Now that you know a little about how frogs jump, you may enjoy making a jumping frog of your own. Grab a square sheet of paper and try your hand at the origami (Japanese paper folding) activity that follows.

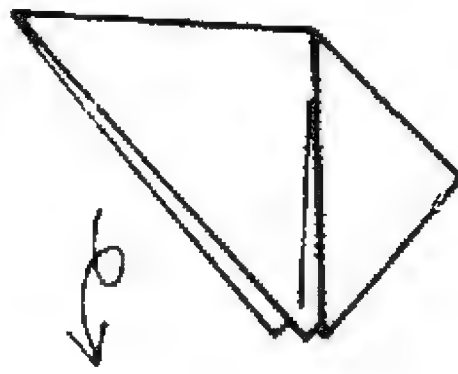
—Joseph M. Lugo

How to make an American Jumping Frog

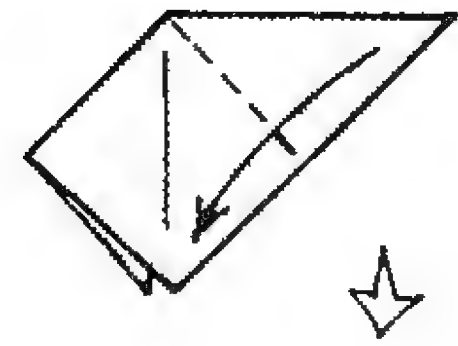
Use a square of paper. First fold it diagonally in half.



1. Fold the top right corner to the bottom point so that the folded edge lies in the center.



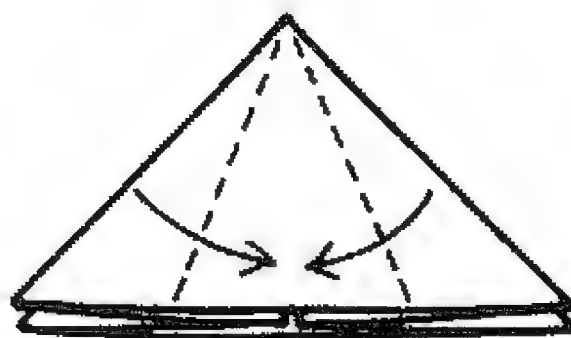
2. Turn the paper over.



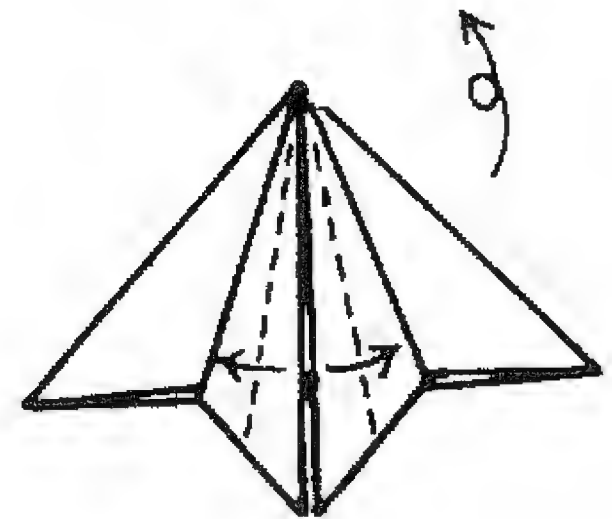
3. Fold the top right corner to the bottom point.



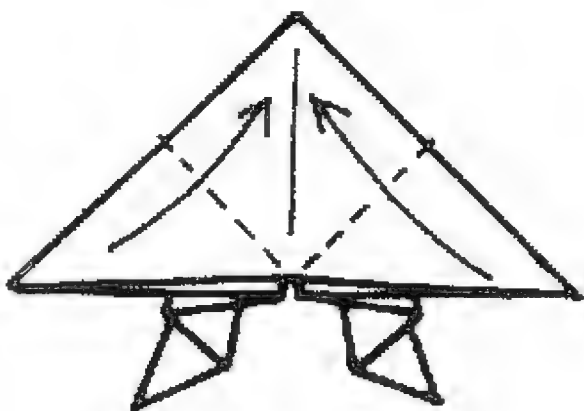
4. Put your thumbs inside and separate the front from the back, allowing the two side corners to come together.



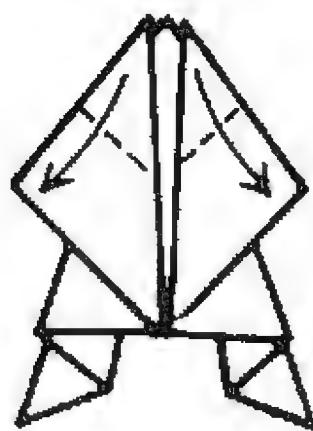
5. Fold the diagonal edges of the right and left front flaps to the center creases.



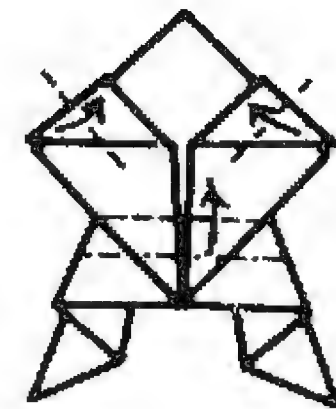
6. Fold them back to the new folded edges. Turn the paper over.



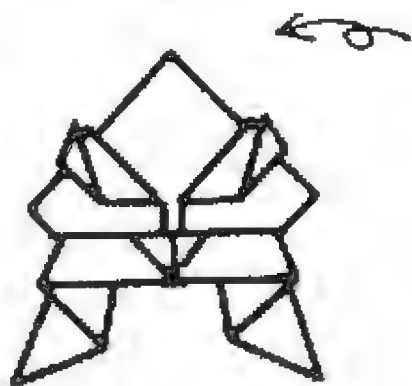
7. Fold up the left and right corners so that they meet at the top point.



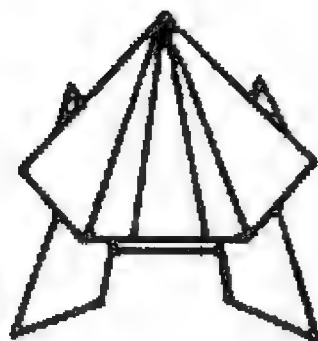
8. Fold them back, in valley folds, to the new corners.



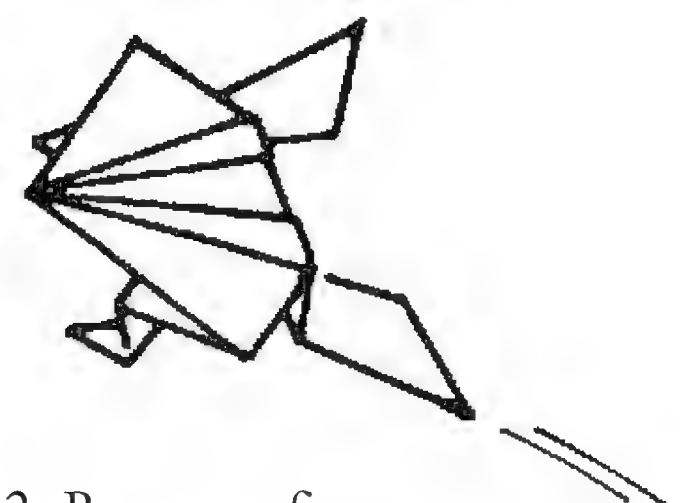
9. Fold up the points of the two top flaps, to make feet. Pleat the waist.



10. Turn the paper over.



11. The completed American Jumping Frog.



12. Run your finger firmly down the frog's back to make it jump.

Origami art taken from Eric Kenneway's book Complete Origami, copyright the British Origami Society.

Art, Science, and Caterpillars



KATHRYN BARRY



hen I was seven years old, I had a girl-friend who ran away from butterflies. For me, spiders were the creatures to avoid. It seems that little girls have always disliked “creepy-crawlies”—but of course there are always exceptions.

In the dawn of the scientific era, Maria Sibylla Merian was one such exception. With her spectacular pictorial documentation of the metamorphosis of caterpillars into butterflies, the 17th-century artist bridged the gap not only between women and insects, but between art and science. Merian’s scientific illustrations took her from the gardens of Germany to the tropical forests of Suriname, where she studied and drew hundreds of butterflies and the plants they lived on. Her combination of color, aesthetics, and technical accuracy left a legacy for both entomologists and natural science illustrators.

The daughter of a celebrated engraver, Maria Merian was born into a middle-class German family in 1647. Her father died three years later. On his deathbed, her father said, "I will not be completely forgotten, for one day they will say, 'That is Merian's daughter.'" He was right.

Maria's mother later married a Dutch

flower painter who, appreciating Maria's talent, nurtured her efforts to learn drawing, painting, engraving, and embroidery. By the time of her own marriage at age 18, Maria had established herself as a flower painter and embroiderer of distinction. While her husband, also an artist, struggled to establish himself by painting architectural subjects,

Maria's career flourished.

Recalling her youth of raising silkworms, Merian said she wanted to "embellish [her] floral designs with caterpillars and butterflies, to enliven one, as it were, with the other." Fascinated by the metamorphosis from caterpillar to butterfly, she studied the insects and drew each phase of their life cycle. Unlike many artists of her day, she depicted the insects with realistic detail and in conjunction with the plants they fed upon. At 32, one year after the birth of her second daughter, she published her first large collection of engravings, *The Wondrous Transformation of Caterpillars and Their Remarkable Diet of Flowers*.

Up to this point, Merian's life was successful, though not particularly unusual. Middle-class German women often worked, and daughters of artists often followed their fathers' career paths. But the publication of the caterpillars book in 1679 not only gained Merian a reputation as a superb artist, it launched her into the realm of science. Though not the first to document the metamorphosis of caterpillars into butterflies, Merian was undoubtedly the first woman to enter the field of entomology. The prominent male scientists of her time—Johannes Goe-daert, Thomas Moffett, and Johann Swammerdam—were concurrently publishing the first detailed academic studies of insects.

The scholars also included engravings of their subjects, but Merian alone appreciated the beauty of insects and visually conveyed this appreciation to the layperson. While the scholars' black-and-white engravings focused on anatomy and classification, Merian's illustrations radiated with color. She transmitted the concept of metamorphosis from scientists to the public of her day, who generally considered nature and all things natural to be common and vulgar.

Merian's life diverged further from the norm in 1684. Separating from her husband, she moved to Holland to join the Labadists, a pietist religious sect founded by ex-Jesuit Jean de Labadie. The community provided Merian with security for her children, the time to pursue her interests, and the chance for the greatest adventure of her life.

Merian lived during a time of social and political upheaval. A century of wars had left more than 150,000 German villages devastated and the population reduced by half. Culture and art were just beginning to recover from the impact of continual warfare, and at the end of the 17th century, the Enlightenment—with the revolutionary ideas of Bacon, Hobbes, and Newton, and the philosophical treatises of Descartes and Spinoza—was taking hold in Germany.

Holland, meanwhile, had emerged as a world power as Dutch explorers established colonies in North and South America and in Asia. As art and science flourished amid Holland's economic prosperity, several of Merian's peers in those fields also joined the Labadists. More fortunate for Merian was



Papilio achilles. In his 1788 *Systema Naturae*, Linnaeus cited Merian as a discoverer of this species. Plate 7 from *Metamorphosis insectorum surinamensium*.

her introduction to the owner of the castle in which the community lived. Cornelius van Sommelsdijck served as the governor of the Dutch colony of Suriname, and had brought back a collection of brilliant South American butterflies. Showing them to Merian, he planted the seeds of her interest in visiting Suriname.

After the Labadist sect dissolved in 1688, Merian moved to Amsterdam, where she became friends with the director of the Amsterdam Botanical Gardens. He supported her interest in tropical butterflies, and persuaded the city of Amsterdam to finance a trip to Suriname. At age 52, Merian and her second daughter Dorothea left for South America.

Though fertile ground for her artistic pursuits, Suriname offered Merian no comfortable setting in which to accomplish her work. Travelers of the day risked death from poorly ventilated ships, heat, and tropical diseases. Explorers and colonists tolerated the harsh Suriname environment because they could exploit the land for precious wood, sugar, and rubber. But they had little tolerance for two women traveling alone who only wanted to paint butterflies, and rarely befriended the travelers.

After two years, Merian surrendered to the hardships of the tropics. "It is extremely hot, so that it is impossible to work but with great difficulty and I had all but paid with my life; therefore, I could not remain there," she wrote to a friend. Maria and Dorothea returned to Amsterdam in 1702.

Back in Holland, Merian supervised the engraving of her watercolors of butterflies, producing her most famous and scientifically important work, *Metamorphosis Insectorum Surinamensium*. Though her work was praised in both the artistic and scientific communities, her attempt to link natural history and art also received criticism from both disciplines. Artists criticized her handbook portrayal of all phases of an insect's life as unartistic. Scientists took issue with her sometimes-mistaken relationships between larvae and adults and between insects and the plants she presumed they fed on. And after her death in 1717 they quickly forgot her work because she did not develop a systematic way to categorize insects, a priority for other natural historians.

Yet her drawings were generally so precise that Linnaeus referred to her work when naming over 100 species in *The Systema*, which introduced the now-standard method of naming and classifying species in 1758. He also named two species of European butterflies after her, *Papilio sibilla* (later renamed *Papilio lucretia*) and *Papilio merianella*. In addition to her insect designs, Merian completed 35 other designs comprising a garden and herbal series. Though never published, they were collected with many other originals in the 18th century by Peter the Great of Russia and are still in the Academy of Sciences of the Soviet Union. Many of Merian's works from the caterpillar and Suriname series can



Papilio polycaon feeding on *Hibiscus mutabilis*. Linnaeus cited Merian regarding this plant. Plate 31 from *Metamorphosis insectorum surinamensium*.

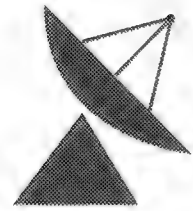
be seen at the National Museum of Women in the Arts in Washington, D.C.

A superb artist and self-trained entomologist, Merian was a pioneer in the field of scientific illustration. She was also one of the first Europeans to travel overseas for a biological purpose, and one of the few women of her time to travel great distances on her own. Her industry, keen powers of observation, and willingness to transcend disciplinary and

social conventions serve as an inspiration to artists and scientists of all ages. ♣

Kathryn Barry interned with the Publications Office last year and is now an environmental editor and writer based in Seattle, Washington.

All photos in this article courtesy of Smithsonian Institution Libraries.



EYE *In The* SKY

ROBIN MEADOWS

Nova Scotia biologist Fred Harrington can track caribou in his sleep—and when he's walking down the street or working in his office at Mount Saint Vincent University. How does he do it? Like many wildlife biologists today, Harrington tracks with satellites that receive signals from radio-collared animals and relay the information through a series of links to his computer. Before switching to this automated method, he had to follow the caribou by airplane because conventional radio-tracking receivers have a maximum range of only about 20 miles. Besides being time-consuming and subject to the weather, aerial surveys are so expensive that Harrington could afford only three a year; during the intervening periods he had to make do with connecting the dots between known locations, a poor second compared to the year-round data he now gets via satellite.

Knowing where the caribou (*Rangifer tarandus*) are from day to day can be essential to protecting them. As they migrate thousands of miles, foraging on lichens and grasses, the 220-pound Arctic caribou run the risk of being caught in the sudden floods generated by hydroelectric engineers in remote areas of Quebec. When too much water builds up behind one of the many hydroelectric dams in the eastern Canadian province, engineers divert the excess by opening flood gates on the river, and the ensuing torrents of water can be

deadly—thousands of caribou were pushed over a waterfall on the Caniapiscau River in 1985. As Harrington points out, this disaster could have been avoided if biologists had been keeping track of the herd by satellite. Similarly, knowing where caribou are calving will help the military reroute the low-level flights that flush the mothers, leaving their young vulnerable to predators.

Harrington is in his fourth field season of tracking caribou with a weather satellite system launched in 1978. The system, a joint project between France and the United States, consists of two Tiros-N satellites (which are American) equipped with the Argos Data Collection and Location System (which is French). Originally designed for collecting environmental data from transmitters on land, on drifting ice, or in buoys or ships on the ocean, the Argos system was extended to tracking animals in the early 1980s when people developed transmitters small enough to attach to animals. Upon receiving radio signals from a tagged animal, Argos relays the data to processing centers in France and in Maryland in the U.S. that calculate and then send the animal's location to biologists via computer or telephone.

In addition to revealing where all sorts of animals roam, satellite tags can tell biologists what the animals are doing. The Alaska Fish and Wildlife Research Center, part of the United States Fish and Wildlife Service (USFWS), is using satellite collars equipped with sensors that detect salt water, temperature, and activity, all of which can be correlat-

ed with animals' behavior. Salt-water sensors tell biologists when walruses are in the ocean and the percentage of time that polar bears spend in the ocean. Temperature sensors can show when the bears are in their dens because these snow caves are much warmer than the outside air—about 35 degrees Fahrenheit versus -30. In addition, activity sensors, which contain a ball of mercury that rolls when an animal tilts its head, give biologists an idea of how active the animal is. For example, based on observations of captive caribou, activity counts of less than five per minute generally mean the animals are lying down, while counts of more than 55 per minute signify running.

But for all its virtues, satellite-tracking is not perfect. Although satellite-tracking is far cheaper than conventional tracking on a daily basis (\$10 to \$30 a day versus several hundred dollars per hour), satellite transmitters cost 10 times as much as conventional ones (roughly \$3,500 versus \$350). This higher initial expense forces biologists to tag fewer animals and, as Harrington says, "you have to hope you don't put collars on screwball animals." Besides being expensive, commercial tags, at 3.5 pounds, are too heavy for most species to wear unhampered. However, compared to the 24-pound collars pioneered by John Craighead and his colleagues at the Wildlife and Wildlands Institute in Montana, today's tags weigh much less and companies are working toward even lighter models.

Another problem with satellite-tracking is that the accuracy depends on the number of

signals received (uplinks) during a satellite pass, which takes about 15 minutes. Transmitters send a signal once a minute and a satellite must receive at least five signals during seven consecutive minutes for an Argos-calculated location to be accurate within about half a mile. Unfortunately for biologists, tagged animals don't always meet this uplink rate because, unlike weather buoys, they don't always hold their transmitter antennae toward the sky—and a caribou that lies down on its antenna blocks transmission. The problem of blocked transmission is particularly acute in satellite studies of marine animals such as seals because immersion in salt water completely stops radio signals. Between dives, seals typically bob at the surface so briefly that there are only two uplinks during a satellite pass, which translates to a location "accuracy" of 20 miles.

These limitations are minor, however, in light of the fact that satellite-tracking is the only feasible way to follow marine animals swimming in the open ocean or land animals traveling across expanses of, for example, snow-covered Alaskan tundra. Determining the ranges of Alaskan animals is essential to protecting migration routes, breeding grounds, and other crucial areas that could be imperiled if Congress approves a hotly contested proposal to search for oil and gas in the coastal plain of the Arctic National Wildlife Refuge in northeast Alaska. Bounded by Canada and the Beaufort Sea, the coastal plain is a traditional calving ground for one of the state's largest caribou herds (estimated at 180,000), says wildlife research biologist Gerald Garner of the Alaska Fish and Wildlife Research Center. In spite of the coastal plain's importance to the caribou, a 1987 Department of the Interior report to Congress advised that the refuge be opened for "limited development," which would entail oil drill pads, pipelines, roads, and airstrips cutting 330 miles east-west across the northernmost part of the refuge, effectively severing the coast from the rest of the reserve. The Interior Department's recommendation is particularly shortsighted considering that, according to estimates in a 1987 U.S. Geological Survey (USGS) Bulletin, the refuge contains at most 10 billion barrels of recoverable oil and the U.S. uses six billion barrels in a single year. Furthermore, the USGS estimates that the reserve's natural gas would not be economical to remove for the next 40 years. However, developers cannot proceed without an act of Congress, and Garner expects that the issue "will be dead" in Congress for some time to come due to the uproar over the March 1989 Exxon oil spill, which continues to devastate

In Canada, satellite-tracking may be essential to protecting caribou from being flushed by low-flying military planes or caught in floods generated by hydroelectric dams. (Photo by Fred Harrington.)



marine life in Alaska's Prince William Sound. In the meantime, USFWS biologists have stepped up their use of satellite-tracking in the Arctic National Wildlife Refuge and are now following 30 caribou, six grizzly bears, and five musk oxen. By overlaying data from the tagged animals on a map of the proposed oil and gas development, the biologists will be able to define the development's adverse effects on wildlife more fully.

Besides helping biologists assess potential threats to animals, satellite-tracking is a valuable tool for identifying current threats to declining species such as the Steller's sea lion (*Eumetopias jubatus*). Found along the Pacific Rim from Japan to California, these shaggy-maned, reddish-brown sea lions are concentrated in Alaska. Sadly, the southwestern Alaska population has plunged from an estimated 140,000 in 1960 to only 68,000 today, a 52-percent decrease that may be related to the rise of commercial fisheries in Alaskan waters, according to Richard Merrick of the National Marine Mammal Laboratory in Seattle, Washington.

While Steller's sea lions will eat squid and other invertebrates, fish are the mainstay of their diet and the correlation between the decline of the Alaskan sea lion population and the rise in fishing is striking. For example, in the late 1960s commercial fisheries began expanding their operations in the waters around Ugamak Island in the eastern Aleutians to take advantage of what was then one of the biggest concentrations of pollock. Before the fisheries' expansion, the island had

15,000 adult Steller's sea lions while today there are only 2,000, a decrease of nearly 90 percent. But a correlation, no matter how striking, is not proof. To establish that there is a conflict between the fisheries and the sea lions, biologists must prove that these marine mammals feed in areas that are fished commercially. However, beyond knowing that the sea lions congregate along the coast in the summer to bear young and breed, biologists know little about where they go. Thus, Merrick is satellite-tracking several sea lions as a first step in determining the cause of—and reversing—the species' decline.

Satellite-tagging marine mammals is challenging because their heads are so tapered that collars just slip off. Merrick overcomes this difficulty by epoxying transmitters to the fur between the sea lions' shoulder blades. Tagging whales is even trickier because they lack fur, and Bruce Mate of Oregon State University has found that the best approach is to implant transmitters in the blubber, which lacks nerves so that the procedure is essentially painless.

Mate is satellite-tracking right whales (*Balaena glacialis*) to learn why they are still endangered despite a 53-year international whaling ban. Up to 60 feet long, these black baleen whales were dubbed the "right" whales to hunt because they often swim slowly at the surface, making them easy to harpoon, and float when dead, making the carcasses easy to retrieve. Further adding to the right whale's desirability, a single carcass yielded up to 90 barrels of oil and nearly 1,700



An activity sensor on this caribou's satellite collar tells trackers that it is lying down. The sensor contains a ball of mercury that rolls when the animal tilts its head; the lower the rate of rolls per minute, the less active the animal. (Photo courtesy of Gerald Garner, Alaska Fish and Wildlife Research Center.)

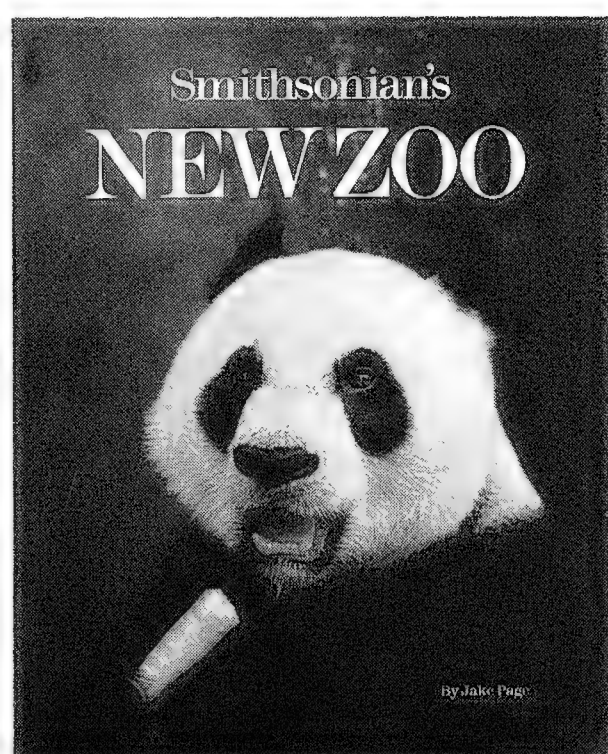


Biologists track polar bears and other animals across the frozen tundra to determine whether their migration routes and breeding grounds could be threatened by proposed searches for oil and gas in the Arctic National Wildlife Refuge. (Photo courtesy of Gerald Garner, Alaska Fish and Wildlife Research Center.)

pounds of baleen, which was prized for its strength and elasticity. Whalers rapidly depleted right whale populations by first taking calves to lure the mothers close to shore for an easy kill.

Right whales live in temperate waters all around the world but only an estimated 4,000 are alive today. While some populations show signs of recovery, the outlook continues to be bleak for others because the whale's habit of frequenting nearshore waters makes the species vulnerable to coastal development, marine pollution, and boats—of the 350 right whales known to live in the North Atlantic, 70 percent bear scars from collisions with ships or entanglements in fishing gear. Saving these remaining whales depends on knowing everywhere they go because, Mate notes, the entire habitat is critical to an endangered species. However, as in the case of Steller's sea lions, biologists know little about the range of right whales and so Mate is tracking them by satellite to discover their breeding and calving waters and their migration routes.

By defining the habitat of an animal, biologists can give governments incontestable reasons for preserving the areas of wilderness that are vital to the species' survival. Thus, over the past decade satellite-tracking has become one of the most powerful tools for protecting animals. And as companies produce lighter transmitters in the coming decade, many more species will enjoy the benefits of being tracked by satellite. ♣



Ling-Ling, the Zoo's famous female giant panda, as featured on the cover of Smithsonian's New Zoo by Jack Page. (Photo by Jessie Cohen, NZP Graphics, courtesy of Smithsonian Institution Press.)

Perceptions of Animals in American Culture. 1989. Edited by R.J. Hoage. Smithsonian Institution Press, Washington, D.C., and London. 151 pp. softbound, \$11.95.

Smithsonian's New Zoo. 1990. Jake Page. Smithsonian Institution Press, Washington, D.C., and London. 224 pp. hardbound, \$29.95.

Lords of the Air: The Smithsonian Book of Birds. 1989. Jake Page and Eugene S. Morton. Smithsonian Institution Press, Washington, D.C., and London, and Orion Books, a division of Crown Publishers, Inc., New York. 288 pp. hardbound, \$40.00.

Three new books connected with the National Zoo provide fascinating insights into the relations between animals and humankind. If you are one of the many Zoo visitors who adore pandas but detest snakes, you may better understand your feelings after reading *Perceptions of Animals in American Culture*. Edited by NZP Chief of Public Affairs Robert Hoage, this provoca-

tive collection of essays by various authors (the result of an NZP symposium funded partly by FONZ) examines our complex and often contradictory views toward animals, especially our tendency to "anthropomorphize," or attribute human qualities to them. The writers debate whether anthropomorphism arises from historical circumstances, popular culture, psychological and biological needs, or evolutionary adaptation, and how it affects wildlife conservation.

Erich Klinghammer's essay on wolves includes many of the book's themes. Western farmers and ranchers have hunted wolves into near-extinction partly because European-American culture has demonized wolves in such stories as "Little Red Riding Hood." The species' plight has converted many other Americans into wolf-lovers, some so eager to exonerate the animals that they deny that wolves hunt livestock at all. The essay implies that we cannot protect both wolves and livestock until we see them as animals and not moral symbols.

Other essays treat anthropomorphism in Disney cartoons; the feelings of security and intimacy that people receive from pets; the historical roots of the animal welfare movement; the psychological similarities between humans and animals; animals in TV commercials and viewers' self-images; and the reason for the human fear of snakes—is it instinct or culture? At the end, the book suggests that, in order to develop consistent ethical standards for the treatment of animals, we must see them more objectively, without sentimentality or loathing.

Jake Page, former editor of *Smithsonian* magazine and a man with a long-standing affection for the Zoo, guides you on a private tour of the hidden Zoo in *Smithsonian's New Zoo*. With an introduction by the Smithsonian's Thomas Love-

joy and an afterword by NZP Director Michael Robinson, the book features hundreds of splendid color photographs of tigers, elephants, and other beasts. You learn how the Zoo staff designs exhibits and how the veterinarians in the Department of Animal Health prevent and treat animal diseases. The Zoo's menu for its residents is astounding: 450 pounds of meat each week for the lions and tigers, and 38,000 crickets a week for other animals such as monkeys and frogs.

Page shows how the Zoo carries out one of the most vital missions of a world-class modern zoo: the conservation of endangered species. Whereas zoos once captured animals from the wild, today the National Zoo seeks to place zoo-born animals back into the wild. For example, rare golden lion tamarins born in zoos learn the arts of foraging for food and avoiding predators in Beaver Valley before being reintroduced to the Brazilian forest.

The author then takes you around the globe with Zoo scientists studying tigers, rhinoceroses, elephants, deer, hoatzins, and iguanas in Nepal, Sri Lanka, Venezuela, and Panama. Closer to home, you see the 3,150-acre Conservation and Research Center in Front Royal, Virginia, home to such rare species as the tiger quoll, the multi-hued sable antelope, the tall and graceful red-crowned crane, and the second-largest herd on earth of Pere David's deer, extinct in the wild for centuries. And right here in the Zoo, researchers seek to apply the latest advances in genetics, in vitro fertilization, and artificial insemination to rescue species menaced by extinction.

If you have followed news items in *ZooGoer* about individual research projects, the vivid text and striking photographs in Page's book will give you a comprehensive look at

the Zoo's research programs, as well as new insight into the management of exhibits and animals.

Jake Page collaborated with Zoo ornithologist Eugene Morton on another gloriously illustrated work, titled *Lords of the Air: The Smithsonian Book of Birds*. As Smithsonian Institution Secretary Emeritus S. Dillon Ripley writes in his introduction, "Almost from its beginnings, the Smithsonian Institution has been a center for the scientific study of birds, originally describing the state of nature in our new nation and now perhaps warning us of the decline of our environment." The book documents the long history of humankind's fascination with birds through artistic and other cultural images. We have marveled at their brilliant plumage, melodious songs, and most especially their powers of flight.

The scientific study of birds has both provided answers and raised new questions about the history of life on earth. By studying the finches of the Galapagos Islands, Charles Darwin was able to formulate his theory of evolution by natural selection. Yet, even after a century and a half of modern ornithology, evolutionary biologists still debate the exact bird ancestors among the dinosaurs.

Besides exploring these intriguing subjects, the book explains the wonders of flight, navigation, and migration; describes avian subsistence, communication, and social structure; and examines the perils from human overdevelopment. The numerous and stunning color photographs demonstrate the amazing diversity of birds in their size, shape, color, behavior, and habitat.

Whether you prefer pandas to snakes or snakes to pandas, these three books may help you to appreciate animals on their own terms as well as on yours.

—Karen MacKavanagh

Monitoring Monitors

All through the night we had heard elephants trumpeting in our study area. It was still quite dark at five in the morning, and we were more than a little apprehensive as we headed out to locate the monitor lizards we were radio-tracking. Our project was to study the ecology and behavior of two species of monitor lizards, the

Bengal monitor (*Varanus bengalensis*) and the water monitor (*Varanus salvator*), at Uda-Walawe National Park in Sri Lanka.

Thirty-seven species of monitor, or varanid, lizards are distributed from East Africa through Asia into Australia; this group includes the largest living lizards. Of the two species we were studying, the

Bengal monitor is smaller, reaching a total length of about 1.5 meters. The water monitor, the second largest lizard in the world after the Komodo dragon, becomes twice as large: The largest water monitor we captured during this project measured almost three meters in length. In most parts of the world where they occur, the larger monitor lizards are heavily hunted. Indeed, despite its extensive range in Asia, the Bengal monitor is listed as endangered. In Sri Lanka, however, hunting pressure on these animals is very light. Both species are common visitors to suburban gardens and can even be found wandering the streets of large cities!

We sought to study the ecology of both species so as to learn more about the types of habitats, microhabitats, and microclimates they require and about interspecific interactions, knowledge that will help the implementation of judicious conservation programs. It is important to protect these animals because, being near the top of the food chain, they play an important role in ecological communities by regulating animal populations lower in the chain. They also have economic importance because some of the populations they regulate are crop-damaging rodents and insects.

We also wanted to gain some insight into the physiology and ecology of large reptiles. Like other "cold-blooded" animals (the correct

term is "poikilothermic"), these lizards maintain their optimal body temperatures by selecting habitats with the proper temperature conditions; this is called behavioral thermoregulation. Most lizards resort to two broad thermoregulatory strategies. Some lizards, called thermoregulators, attempt to maintain a relatively stable body temperature by constantly choosing habitats with temperatures that enable them to achieve and maintain the desired body temperature. Other lizards, called thermoconformers, do not attempt to maintain a constant body temperature but allow body temperature to change with the environmental (or ambient) temperature. These thermal strategies are important because they influence activity patterns, feeding strategies, and interactions between individuals and between species.

We were interested in studying the ecology of these two species to see if and how they partition resources as predicted by ecological theory. We knew that they had very similar diets, and ecologists have long believed that "coexisting species that compete for a common resource must either specialize and partition resources to reduce interspecific competition, or one species will become extinct in that part of their range of coexistence." Translated, this means that if two or more species live in the same area and eat the same types of food that are in short supply, there should be differences in their behavior that



Water monitors maintain a constant body temperature by retreating to shade or water as the day grows hotter. This behavior is called thermoregulation. (Photo by Eric Wikramanayake.)

separate them in space or time.

To answer these questions, we used radio telemetry to follow and observe the monitors throughout the day and, at regular intervals, to measure the temperature of their habitats or microhabitats. We captured five animals of each species, glued temperature-sensitive radio transmitters to their backs, and released them at the same places where we had caught them. Then we proceeded to monitor monitors!

The radio signal gave us their location and enabled us to find them easily. The signal also gave us the temperature at the animal's exact location, that is, its microhabitat temperature. By comparing that temperature to the outside, shaded temperature (ambient temperature), we could tell whether or not the animals were selecting microhabitats with temperatures different from ambient temperatures. For instance, the temperature under a bush or in a burrow may be less than the ambient temperature, and at midday the temperature out in a sunny, open area will be warmer than the shaded ambient temperature. We were also able to obtain body temperatures by inserting a thermometer in the cloaca of captured animals. With these data we could tell whether the species were thermoregulators or thermoconformers. By following the radio-tagged animals from six in the morning until six in the evening over a peri-

od of days, we could also determine their activity patterns, foraging methods, and habitat and microhabitat use.

Our results revealed that the water monitor is a thermoregulator and maintains a fairly constant body temperature throughout the day and night by selecting cool microhabitats when ambient temperature is high, warmer microhabitats when ambient temperature is low. Because the water monitor's body temperature roughly equals water temperature in rivers, streams, and lakes, it can forage in aquatic habitats without losing too much body heat. The low body temperature also means that if it forages on land, it must become active early in the day, because when ambient temperatures rise, it has to retreat to cooler microhabitats such as thickets or the riparian forest, or into aquatic habitats to prevent overheating.

In contrast, Bengal monitors proved to be thermoconformers. They have a much higher active body temperature than water monitors as well as a higher body temperature than the daytime ambient temperature. However, at night they enter refugia, such as burrows, termite mounds, and tree hollows, and their body temperature drops considerably, even below ambient temperature. At these low body temperatures, their movements become very slow. Therefore, before they can become active and begin foraging again the following day, they have to raise their

body temperatures by basking in the sun. Thus they emerge from the refugia later in the day when the sun is out and the air warmer. As a result, Bengal monitors start to forage when the water monitors begin to seek cooler microhabitats. By adopting two different ecophysiological strategies that tend to separate them in time and space, the two species avoid competition.

This information allows us to provide the proper habitats for both species and tells us how ecological communities are structured. Furthermore,

we now intend to transfer our research methods to a study of the ecology, behavior, and demography of the Komodo dragon, the world's largest lizard. The species is confined to the four small islands of Komodo, Padar, Rintja, and Flores in southern Indonesia and is currently endangered. The information collected from the study will facilitate the conservation and management of these animals by the Indonesian Department of Forestry and Nature Conservation.

—Eric Wikramanayake
NZP Postdoctoral Fellow



BOB HUMPHREY

Sunset Serenades

If you're looking for a way to relax with your family, bring a blanket to Lion/Tiger Hill for Sunset Serenades, the Zoo's annual series of free outdoor concerts for all ages. The concerts run each Thursday evening, 6:30 to 8:00 p.m., from June 21 through July 26. John Lyon and the Gross National Product kick off the series on June 21 with folk tunes and originals, followed by the Mariachis de las Americas on June 28 and the pop/jazz band Penguin on July 5. Rockcreek offers bluegrass on July 12, the Lazy River Dixieland Jass Band performs on July 19, and Rumisonko concludes the series on July 26 with Andean folk music. Bring your own supper or enjoy a picnic basket from FONZ by calling 673-4978 at least 24 hours before the concert. Programs will be canceled only if it rains at the start of or during the concert. For more information, call 673-4717.

Centennial Awards

Donald Lindburg, a research behaviorist at the San Diego Zoo, recently won the first National Zoological Park/Friends of the National Zoo Centennial Award for Excellence in Zoo Research for his paper "Proceptive Calling in Female Lion-Tailed Macaques." At a National Zoological Park ceremony on April 27, Lindburg received his award and presented a short

talk based on his paper, which will be published in *Zoo Biology*. He began studying macaques in India while doing pre-doctoral work at the University of California at Berkeley, and also studied macaques in Borneo during 1972 and 1973. Later he taught anthropology at the University of California at Los Angeles before joining the San Diego Zoo staff in 1979. In addition to his regular duties, Lindburg serves as editor of *Zoo Biology* and chairperson of the Cheetah Research Council for the American Association of Zoological Parks and Aquariums.

Wildlife Lecture Series

Take advantage of the long summer evenings to educate yourself about endangered wildlife. In conjunction with the Zoo, the Smithsonian Resident Associates Program and the World Wildlife Fund (WWF) are co-sponsoring a series of four slide-illustrated lectures by international experts on conservation.

Tom McShane and Erica McShane-Caluzi of the WWF Africa Program present "Conservation Before the Crisis: Elephants, Rhinos, and Gabon" on Thursday, June 14. They will show you how the West African nation of Gabon is trying to protect its wildlife treasures now, before development threatens them.

On Thursday, July 19, travel with Roger Stone of WWF from Maine to Rio de Janeiro

on "The Voyage of the Sanderling." Stone will share with you the dismay of seeing widespread pollution along the Atlantic coast and the excitement of visiting remote Caribbean islands where Columbus reputedly made landfall.

Finally, on Wednesday, August 15, find out from Rob Bierregaard of WWF what may help "Birds in the Amazonian Rainforest," which are increasingly isolated in small pockets of forest as surrounding land becomes cattle pasture.

All lectures will take place at 7:00 p.m. in the Education Building at the Zoo. The cost of each lecture is \$7 for members and \$9 for non-members. You can also reserve a box dinner and drinks by calling 673-4978 at least 24 hours before the lecture. For more information, call the Smithsonian Resident Associates Program at 357-3030.

New Research Building Opens

After complete renovation, the former Hospital/Research Building was formally reopened on April 27 as the Center for Biological Research and dedicated to S. Dillon Ripley, Secretary Emeritus of the Smithsonian Institution, for his enormous contribution to the development of research programs at the Zoo. The Center brings the Department of Zoological

Research together in one place for the first time; previously DZR occupied space in Holt House and in the Propagation Building as well as in the Hospital/Research Building. The new building includes nutrition and general laboratories; climate-control rooms; special rooms for animal research; a darkroom and audio-visual laboratories; remodeled and much-improved facilities for as many as 200 animals; offices for about 40 staff, students, and associates; ample space for archives and miscellaneous storage; and excellent facilities for conferences and seminars.

Dinosaur Musical

Dinosaurs at the National Zoo? They were extinct long before any zoos existed. But this summer at the Zoo you can see Dinamation International Corporation's and Slim Goodbody's production of *Dinosaurs, Dinosaurs . . . A Mesozoic Musical*. Travel back millions of years with this 40-minute, one-man show incorporating the best of professional Broadway theater. Using audience participation and a blend of science and entertainment, *Dinosaurs, Dinosaurs* teaches the concepts of fossilization, evolution, and extinction while dramatizing five different species of dinosaurs. The musical is being presented in the Education Building Auditorium through Labor Day. On Tuesdays



Serval female with cubs. (Photo by Milton H. Tierney, Jr.)

through Fridays, the show takes place at 10:15, 11:30, and 12:45; on Saturdays and Sundays, at 11:30, 12:45, 2:30, and 4:15. The regular prices are: adults, \$3.50; children three to twelve, \$3.00; children under three, free; and group rate (20 or more), \$2.50. However, all FONZ members will be charged only \$2.50 for admission. For ticket and reserva-

tion information, please call 673-4954.

New at the Zoo

The Great Ape House has two new residents: Chang, a male Sumatran orangutan (*Pongo pygmaeus abelii*), and Holoki, a female western lowland gorilla (*Gorilla gorilla gorilla*). Both animals were born in the wild—Chang in Sumatra

around 1959 and Holoki in Africa around 1966—but have spent most of their lives in zoos. The Department of Mammalogy staff plan to mate Chang with Pensi, the only other pure Sumatran orangutan at the Zoo, as part of the American Association of Zoological Parks and Aquariums (AAZPA) Species Survival Plan for Sumatran orangutans.

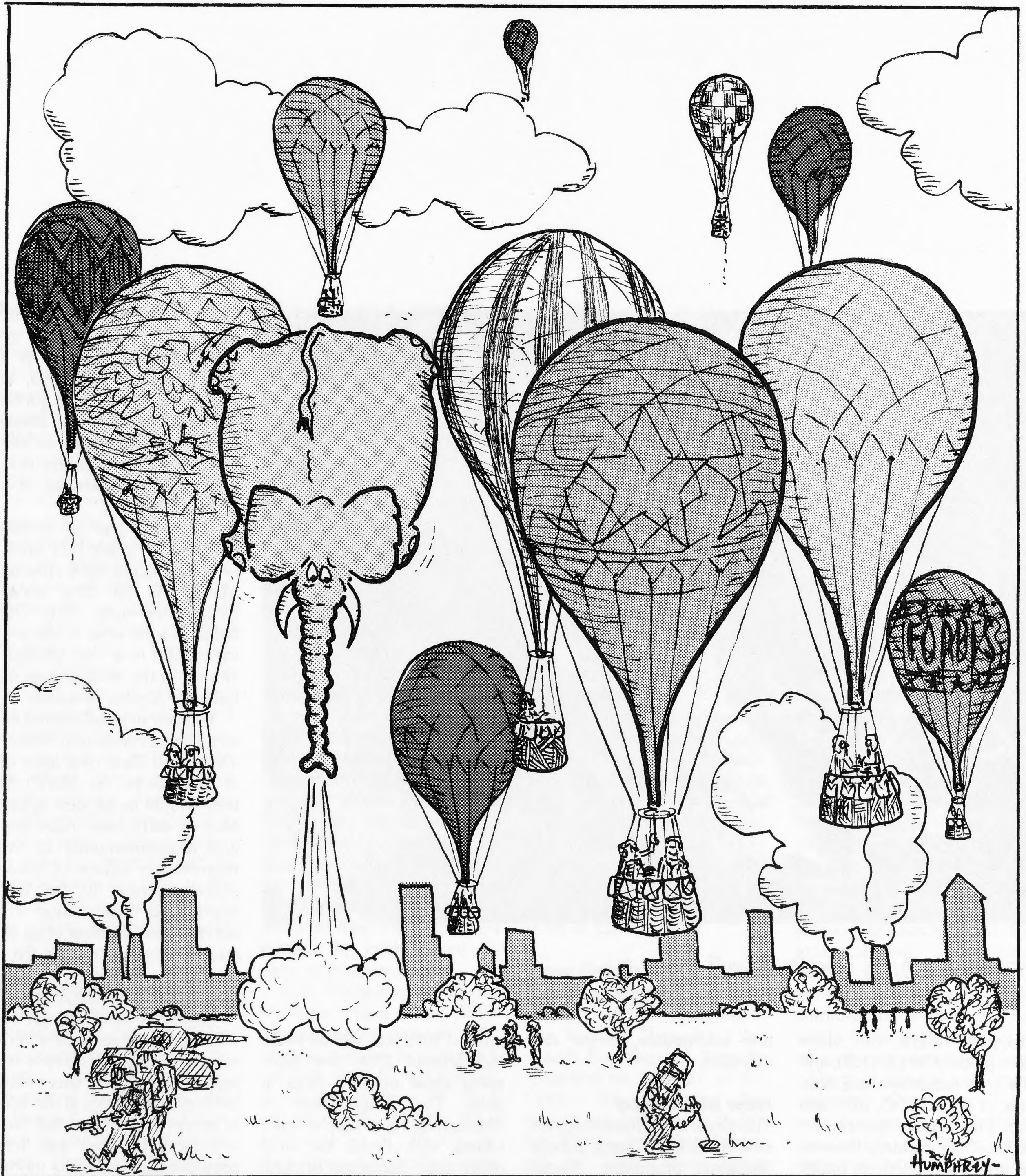
Chang came to the NZP on February 27, and Holoki arrived last December to be a companion for Nikumba, at age 36 the oldest male gorilla in North America. She adapted almost immediately to him and to the three colobus monkeys (*Colobus guereza*) that share the exhibit.

The Zoo's pair of servals (*Felis serval*) made NZP history by producing three cubs on March 16, the first serval births here since 1970. The family can be seen in the serval exhibit near the Monkey House. In the wild, servals inhabit the African savannas.

The pair of small-clawed otters (*Aonyx cinerea*) in Beaver Valley had their own litter of at least three on March 9; they should be on view in late May or early June. After several disappointments in the reproductive efforts of small-clawed otters at the Zoo, it is hoped that these young will survive. The smallest of all otters, this species usually lives in shallow estuaries or rice paddies in Southeast Asia.

Visitors to the Australia exhibit can now see a new red-necked wallaby (*Macropus rufogriseus*), the first successful birth of this species at the Zoo in recent years. Born last November 1, the joey was first seen peeking out of its mother's pouch on February 14. Two red kangaroos (*Megaleia rufa*) have also recently been born in the same exhibit.

The Last Elephant



A professor of anthropology at George Washington University, Bob Humphrey has done archaeological field research in the Potomac Valley, American Southwest, northern Alaska, and Mesoamerica. His cartoons have appeared in numerous publications and he is currently working on a book of "Last Elephant" cartoons.

Fields of Fire

Late last fall I made plans for a spring trip to Brazil to visit Poco das Antas Federal Biological Reserve, site of the Zoo's renowned golden lion tamarin reintroduction project. FONZ has helped to support the Zoo's nearly 20 years of work to save this endangered species. I wanted to see this phase of the program first hand, and was eager to see the zoo-born tamarins now living in their natural habitat.

Then, on February 2, several weeks before I was scheduled to leave, a fire began in the reserve. My departure was suddenly moved up to accompany Ben Beck, the Zoo's Assistant Director for Biological Programs and one of the leaders of the reintroduction project, to perform an on-the-ground assessment of the damage.

As the fire in the 12,000-acre reserve raged out of control, threatening wild and reintroduced tamarins, FONZ and other organizations rapidly organized emergency assistance. FONZ provided \$5,300 to purchase two "Bambi buckets," devices that later figured prominently in the fire-fighting efforts. FONZ also gave Ben Beck \$1,000 to cover emergency expenses at the reserve.

Arriving in Rio de Janeiro on February 12, Ben and I headed immediately for the reserve. Because no direct communication link exists between the reserve and the Zoo, we didn't know what conditions would be when we reached Poco das Antas. Fortunately our worst fears—for the tamarins, for the forest, and for the people who work there—were not realized. But what we did find was bad enough.

By the time we arrived at the field station, the grass and

scrub on the deforested hills that comprise about 20 percent of the reserve were totally burned, but the fires were out. The station itself and even more of the surrounding forested area had been saved. We learned later that this near miracle was accomplished by GLT project workers, IBAMA staff who operate the reserve, and families and volunteers from the nearby town of Silva Jardim.

Still burning with some intensity and the main focus of the nearly 300 professional fire fighters was a habitat much like a peat bog, call *turfa* in Brazil, which is near the eastern border of the reserve. The fire-fighting force was now trying to prevent the fire from spreading from the *turfa* into the forest where the tamarins live. The heroic efforts of this force, working with military precision, were hampered by the heavy smoke and intense heat generated by the fire and compounded by the hot, humid weather.

Helicopters carrying the Bambi buckets were thus deployed to scoop up water from a nearby reservoir and pour it onto blazes that were threatening the forest edges. Firebreaks to further contain the blaze were also being cut along edges by a tractor provided by the town of Silva Jardim. These efforts ultimately saved the forest—and the tamarins—from destruction.

The young trees slowly emerging in the grasslands of the reserve, however, suffered a severe blow. These trees were the foundation for new forest areas to replace the grassland. Experts estimate that the forest recovery program, key to increasing protected forests for tamarin habitat, was set back six or seven



Clint Fields displays one of the Bambi buckets contributed by FONZ to help fight the fire threatening the forest habitat of golden lion tamarins.

years by the fire. A research project that was in progress to study the natural reforestation process was destroyed.

Despite the real devastation and near tragedy, some insights concerning needs and vulnerabilities were gained that should strengthen the GLT reintroduction project, which is already a singular conservation success.

Given the great potential for future grass and forest fires in this area, there is a clear need for:

- Enhanced capability to retrieve endangered wild and reintroduced animals from threatened areas.
- More and better fire-fighting equipment and training of local personnel to use this equipment.
- More rigorous fire spotting and reporting procedures.
- Better communications equipment and procedures, including radio and telephone links within the reserve and between the reserve and local and U.S. project officials.

Brazilian officials and GLT project personnel are already hard at work addressing these and other requirements. The price tag for correcting these shortcomings in any meaningful way is bound to be high, however, and there is little doubt that more help from FONZ supporters will be needed.

While the fire at Poco das Antas received most of my attention, it did not detract from my gaining a greater appreciation for the importance of the project and the brilliant and dedicated efforts of Zoo- and Brazil-supported scientists involved in the project's development and daily operation. On the contrary, the project with the fire as its backdrop served to dramatize the need for intensified efforts to develop and maintain projects for saving endangered species and their habitats.

—Clinton A. Fields
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